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BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

PAPERS IN THIS NUMBER.

"Rehabilitation of Street Railway Tracks." By Frank B. Walker.

Memoir of Deceased Member.

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Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETING.

Boston, September 20, 1922. — A regular meeting of the Boston Society of Civil Engineers was held this evening in Chipman Hall, Tremont Temple, and was called to order at 7.45 P.M. by the President, Prof. Dugald C. Jackson. There were 60 members and guests present.

The minutes of the meeting of May 17 were read and approved, as printed in the June JOURNAL.

The Secretary reported for the Board of Government the names of those elected to membership in the grade of Member:

Members — Messrs. George F. McCann and Harry A. Hageman.

On motion of R. S. Weston, it was voted unanimously that the Board of Government be authorized to use the income from the Permanent Fund to meet current expenses to such an extent as they deemed necessary.

The President announced the appointment of Prof. C. Frank Allen as the representative of the Boston Society of Civil Engineers on the Zoning Advisory Commission of the City of Boston.

Announcement was made of the appointment by the Board of Government of Charles R. Gow as the representative of this Society on American Engineering Council for the year beginning January 1, 1923.

The President spoke of the recent meeting of the Executive Board of American Engineering Council held in Boston on September 8 and 9, and described the part taken by this Society in connection with the dinner tendered to the visiting members of the Executive Board.

Prof. Jackson spoke briefly of the social gatherings held in the Society's rooms in advance of the regular meetings, urging the members to come and partake of the refreshments and meet their fellow members.

The subject of the meeting, "Rehabilitation of Street Railway Tracks," was presented by Frank B. Walker, Chief Engineer, Eastern Massachusetts Street Railway Company. This paper, illustrated with slides, furnished an interesting account of the recent rehabilitation work carried out by the Eastern Massachusetts Railway both on its unpaved country tracks and on the paved city tracks.

A motion picture, showing the construction of track, making use of modern labor saving devices, was exhibited through the courtesy of the Boston Elevated Railway Co.

After considerable discussion of the subject by members and by guests from New England street railways, the meeting adjourned at 10 P.M.

J. B. BABCOCK, *Secretary.*

JUNE EXCURSION.

THE annual outing of the Boston Society of Civil Engineers was held on Wednesday, June 14, 1922, and included an inspection trip to some of the fortifications of Boston Harbor and a shore dinner at Pemberton. A bright, sunny day, the only

one in a period of two weeks, brought out a record-breaking crowd of 160 members and guests and provided ideal conditions for the outing.

Through the courtesy of Brig.-Gen. Mark L. Hersey, commanding officer of the First Corps and Coast Artillery, the inspection trip was made on an Army boat of ample size. The party gathered at the Army Supply Base, South Boston, and left at 1.30 P.M., Gen. Hersey himself being on hand to see that all arrangements were complete. A stop was made at Fort Strong, on Long Island, where Col. Geary, commanding officer of the Boston Harbor defences, came on board to personally conduct the inspection.

The first landing was made at Fort Warren, on George's Island. Here were seen the parade grounds and barracks, the magazines and the mine storehouses. The feature of the inspection was the tripping into battery of a 10-inch disappearing gun by a gun crew while Col. Geary and his aides explained the operation.

At Hog Island, the next stop, the party was met by Lieut.-Col. Willing, of the Corps of Engineers, who is in charge of the construction of fortifications of the very latest type at that point. He conducted the party over the entire plant, including the massive concrete gun placements and the magazines and barracks protected by thick layers of concrete, steel, and sand.

With the inspection concluded, the boat stopped to let the party go ashore at Pemberton. With appetites whetted by the afternoon's exercise in the open the members and their guests gathered in Pemberton Inn and did full justice to the shore dinner there prepared for them. Following the dinner a baseball game was to have been played between the Designers Section and the Sanitary Section; but it was deserted in the rush for the homeward bound Nantasket steamer.

The thanks of the Society are due the Army officers whose hospitality and generosity contributed so largely to the success of the outing.

ERWIN HARSCH,
Chairman, Committee on Social Activities.

APPLICATIONS FOR MEMBERSHIP.

[September 15, 1922.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

DREW, SAMUEL TILDEN, Quincy, Mass. (Age 24, b. Wollaston, Mass.) Graduated from Mass. Institute of Technology in 1921, since which time he has been in the employ of Metcalf & Eddy as assistant engineer. Refers to S. Keith, F. A. Marston, C. W. Rolfe, A. L. Shaw, C. M. Spofford and H. C. Thomas.

SWEET, HERBERT A., Allston, Mass. (Age 32, b. Bridgewater, Mass.) Graduated from Mass. Institute of Technology in 1914 with degree of B. S. in civil engineering. From 1915-16 was bridge inspector and structural engineer on the B. & M. R. R.; 1917-22 engaged in insurance engineering, largely structural engineering, except for five months in field artillery officers' training school at Camp Dix. At present with the Associated Factory Mutual Fire Insurance Co. Refers to H. L. Carter, J. O. DeWolf, G. L. Hosmer, G. E. Russell and C. M. Spofford.

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LIBRARY NOTES.

RECENT ADDITIONS TO THE LIBRARY.

U. S. Government Reports.

Birth Statistics of United States, 1920.
 Bulletins 1031 and 1050, U. S. Dept. of Agriculture.
 Sitka Spruce, U. S. Dept. of Agriculture.
 Statistics of Railways in United States. 1919.
 Water Supply Paper No. 500.

State Reports.

Massachusetts. Annual Report Department of Public Utilities. 1921.

Massachusetts. Annual Report Division Housing and Town Planning.

Massachusetts. Report of Joint Board of Health & Metropolitan District Commission. 1921.

New York. Report of Public Service Commission. 1918, Vol. 2., and 1919, Vol. 1.

Municipal Reports.

- Bangor, Me. Annual Report of Water Board. 1921.
Chelsea, Mass. Annual Report Water Commissioner. 1921.
Fall River, Mass. Annual Report City Engineer. 1921.
Melrose, Mass. Annual Report Public Works Department.
1921.
New Bedford, Mass. Annual Report Engineering Department.
1921.
New Orleans, La. Annual Report Sewerage and Water
Board. 1921.
Providence, R. I. Annual Report Department of Public
Works. 1921.
Providence, R. I. Annual Report City Engineer. 1921.
Reading, Pa. Annual Report Bureau of Water. 1921.
St. Louis, Mo. Annual Report Water commissioner. 1921.
St. Paul, Minn. Annual Report Board of Water Commis-
sioners. 1921.
Taunton, Mass. Annual Report Water Commissioners.
1921.
Waltham, Mass. Annual Report Department of Public
Works. 1921.
Worcester, Mass. Annual Report Superintendent of Sew-
ers. 1921.

Miscellaneous.

- Barium and Strontium in Canada.
Construction Contracts. Springfield-W. Springfield Bridge.
Gift of Fay, Spofford & Thorndike.
Dedication of Hampden County Memorial Bridge. Gift
of Fay, Spofford & Thorndike.
John Fritz Medal. 1922.
Mexican Petroleum. Pan-American Petroleum & Trans-
port Co.
Proceedings Amer. Soc. Municipal Improvement. 1921.
Theory of Structures. Charles M. Spofford.
Wood Preserving Terms. E. F. Hartman & E. F. Paddock.

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BOSTON SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

REHABILITATION OF STREET RAILWAY TRACKS.

By FRANK B. WALKER*, MEMBER BOSTON SOCIETY OF CIVIL ENGINEERS.

(Presented September 20, 1922.)

It is obvious that if tracks are properly maintained, rehabilitation will not be necessary.

The tracks of the old Bay State system prior to its reorganization June, 1919, had not been properly maintained and it became necessary to begin a very heavy program of rehabilitation when the Public Trustees took charge of the property of what then became the Eastern Massachusetts Street Railway Company.

I shall briefly point out some of the conditions under which this work was carried out and explain some of the methods employed, showing a few slides as we go along.

Our system covers the eastern section of Massachusetts, from the Merrimac Valley on the north to Fall River to the south, but with very little mileage in Boston proper. We operate about 700 miles, of which half are unpaved country lines and half are paved city lines. Our country lines are constructed for the most part alongside of town roads and state highways and when the work started three years ago, they were in a deplorable condition, to say the least. They were low and badly drained, the ties were bad, rails out of line, surface and gage, and the joints were low, battered and pounding. We have now com-

* Chief Engineer, Eastern Massachusetts Street Railway Co., 1 Beacon St., Boston, Mass.

pleted the overhauling or reconstruction of about 200 miles, which, together with about 50 miles which were in good condition, gives us 250 miles of very good country track and leaves less than 100 miles to fix up in 1923 when we plan to complete our program.

At the start it was thought necessary to relay the major portion of the mileage of country track with new rail, but with the methods gradually developed we have been able to save many miles of light rail formerly thought worn out. This was done by various methods, such as surface benders, joint welding, surface welding and grinding, all of which I refer to later.

Our city paved tracks were very bad, although not so bad as the country tracks, but bad enough. In cities, street railway engineers are faced with very difficult and expensive problems due to the requirements of street pavements. Country lines are laid with Tee rails, 48 lb. to 75 lb. per yard and paved tracks 90 lb. to 140 lb., 7 in. to 9 in. high, buried in macadam, concrete or granite block pavements. Maintenance and renewals are expensive and reconstruction much more so; yet we have entirely reconstructed 40 miles and have made very substantial repairs to many more miles as well as to completely renew 700 pieces of special work, such as curves, frogs, switches and mates. On both classes of tracks, we have installed very nearly 400 000 ties, — overhauled, rebuilt or repaired about 300 miles, — ground the surface of 75 000 joints and ground the corrugations from the tops of about 120 000 lin. ft. of girder rails in paved streets. We are planning on completing the rehabilitation of the system in 1923, — at least to the point where normal maintenance only is necessary.

Someone has said that the street railways of New England constitute its drainage system. Some of our old tracks seemed to prove this. They were usually well below the highway, completely backfilled, and had no good system of drains. During spring thaws and rainy days many miles were completely submerged. Some of our city tracks were as bad. One winter we lost, by burned out motors alone, the sum of \$600 000.

— Our method of improving this situation was to raise the tracks out of the mud, put in 6 in. to 18 in. of good gravel ballast,

clean off the backfill above the ties by making full open section where we could, or half open in other places, and to dig deep side ditches and off-take ditches. (Figs. 1 and 2.) In this work we were



FIG. 1. — HALF-OPEN SECTION.

Track raised to level of highway with good gravel ballast, backfill cleaned off, deep side ditches and off-take ditches provided.



FIG. 2. — EXAMPLE OF OPEN SECTION TRACKS ON BOSTON ELEVATED RAILWAY.

assisted very materially by the coöperation of city, town and state highway engineers when they realized our purpose and saw the results, and the results have been remarkable. The drainage of

city tracks was accomplished largely by the raising of tracks and the placing of more track catch basins.

The matter of better ties was given considerable thought and we have adopted a good tie for street railway, using on country lines a chestnut tie untreated, 6 in. x 8 in. x 8 ft., although some of these have a face of 6 in. when hewed ties are used. Our paved tracks are retied with 6 in. x 8 in. x 8 ft. yellow pine treated with 10 lb. of creosote oil. Chestnut ties in open tracks have a life of 12 to 15 years and in paved track 18 to 22 years. With treated pine ties we hope to have a life of 25 to 30 years.



FIG. 3. — REHABILITATED TRACK IN FALL RIVER.

7 in. Tee Rail, 91 lb. per yard — tie plates — 6 in. x 8 ft. creosoted pine ties on two foot centres — broken stone ballast — concrete base — stone block paving.

We are ballasting country tracks with at least 6 in. of good, clean gravel and our city paved tracks with at least 6 in. of broken stone, rolling the sub-grade and also rolling the stone ballast before laying the track. Our best country lines are laid with 75 lb. A.S.C.E. Tee rail with welded joints and our paved tracks with 7 in. Tee, 91 lb., or 9 in. girder, 104 lb., — the 7 in. Tee being our standard and used wherever the depth of paving will permit, — tie plates being used on all paved tracks. (Fig. 3.)

All tracks, both country and city, overhauled or rebuilt, have all joints welded and ground, and to me, the process of proper treatment of joints is the most interesting. In fact, your Secretary cautioned me not to spend all my time on welding. We have used several very satisfactory methods of welding joints: the Lorain bar, (Fig. 4 and 5) which is spot welded by an electric current; the Thermit, which is a chemical reaction designed to fuse the rail ends together; and the so-called seam weld by using either the carbon arc or the metallic arc to place a metal bead along the top and bottom of plates at the rail ends.



FIG. 4.—NORTH AVE. WAKEFIELD-READING LINE.

Left hand track completed, right hand track being welded.

All of these methods are good if properly applied. None of them are perfect, but we have for the past two seasons employed the metallic electrode arc method most successfully, and for the moment, believe it to be the best for our work. So far we have never found a failure. True, we have had plates break, also rails break, but these types of breaks do not total 2% of the total joints welded and are probably due to temperature stresses or defective rails or plates. Expansion joints are put in about 750 ft. apart on open tracks, but no expansion joints are needed or ever put in on paved track, as it can be readily shown that if

rail is held in line by pavement, temperature changes produce stresses which are well below the elastic limit of the rail.

In repairing a joint on old rail, we first repair or renew the



FIG. 5.—NORTH AVE. WAKEFIELD-READING LINE.

Left hand track before rehabilitation, right hand track during rehabilitation.

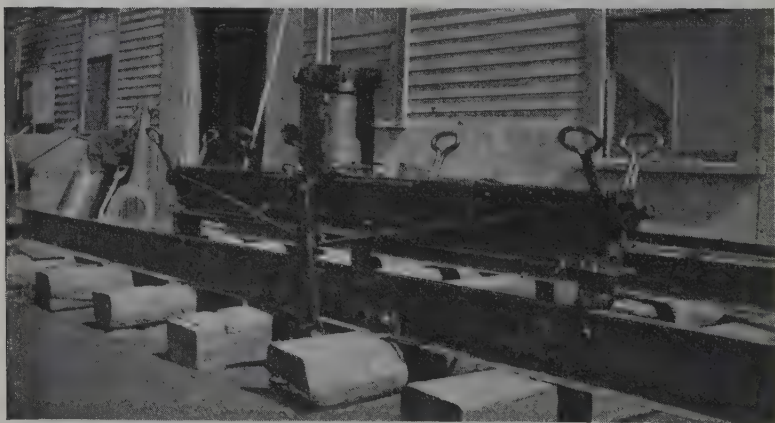


FIG. 6.—VERTICAL RAIL BENDER.

ties, then clean the plates of scale and rust, replace them with bolts or a clamp, bend the rail slightly above the proper surface with a sturdy rail bender of our own design (Fig. 6), retamp the

ties, weld on the plates, surface weld the cup if there is any in the rail and then grind the surface to a perfectly level plane with either a rotary grinder or a reciprocating grinder. The result is a solid, smooth riding joint and one which should require very little maintenance.

New rail is welded the same way, except no vertical bender or surface welding is needed. All joints of new rail are ground to remove all irregularities at the joint due to mill rolling tolerances. We are doing very little bonding at rail joints as the welding serves to carry the negative current return satisfactorily, — the electrical resistance being no more and usually less than the equivalent amount of rail. A recent bond test of 450 metallic arc welded joints a year old indicated 449 of them perfect electrically and one a trifle high. This is considered more nearly perfect than we had ever hoped for.

Our seam welders (not sewing machines) are of the dynamotor or motor generator type, of a reversed polarity, using 20 volts and about 150 amperes. Our surface welders are of the resistance type of much less electrical efficiency due to the high resistance. They are direct polarity. Of grinding machines, we use two general types: the rotary type, using a 14 in. emery driven by a 5 h.p. motor, of which we operate about 30; also the reciprocating type which is essentially 4 carborundum bricks moved back and forth over the rail by a 5 h.p. motor through a crank and eccentric action. We have 10 of these and they are used for grinding corrugations from the heads of rails and on surfaces of joints of new rail. The rotary machines will grind 15 to 30 joints per day and the reciprocating machine 200 to 400 ft. of corrugated rail, — all depending on traffic conditions and amount and depth of corrugation, as well as hardness of the rail.

I have great hopes that metallic arc welding will be used more in structural work. I have already used it in some bridge repairs as, for instance, repairing a damaged I-bar on the Merri-mac River, Lowell. We also assisted the Bridges and Ferries Division in repairing a broken 6 in. turning shaft of the North Chelsea Draw by Thermit welding it. This shaft broke again the other day, but not through the weld.

Our tracks are still far from 100 per cent. condition, but we hope to see nearly 70 per cent. condition in 1923. Better work must be done on street railway tracks than ever before. It is not a solution of large engineering problems or the spending of large sums, but it does mean close attention to details and building up of proper morale of the men and a further training of men in the best way of doing work. We are so confident that the best work can be done only by men properly trained, that we conducted a Winter Track School during last December, January and February, in which we attempted to train 125 of our engineers, roadmasters and foremen. Illustrated lectures each morning of the week were followed each afternoon by shop work and the results obtained this year by instructing these men amply repaid our efforts in conducting the school.

It will be noticed that in my discussion of the rehabilitation of tracks, I have made no particular reference to the effect on the cars which operate on our tracks. There has been a marked change in the weight and character of rolling stock in use on street railways during the past few years.

On our own lines, when the old horse cars were remodeled for electric traction the companies were using cars with a weight of approximately 7 tons. Many of these were the old horse cars with motors on them, but as a general rule most of the early equipment was very light. First they had 4 wheels, and later, as the weight and length of cars increased, double cars of 8 wheels were used. Weight gradually increased from the early nineties to about 1918 when they were operating cars of from 22 to 25 tons.

The equipment on our property was getting in very bad shape, not only on account of lack of maintenance of the equipment, but due to the constant jarring and pounding which the cars received as they passed over bad joints. During the last few years, street railway companies, particularly our own, have started to use a very much lighter equipment, and the so-called Birney safety car, of which we have several hundred, weighs 8 tons. These have 4 wheels spaced 8 ft. between axles.

Recently, a few cars with 8 wheels have been purchased which weigh 13 tons.

We are already noticing considerably decreased maintenance costs in our track due to the fact that more light weight cars are being operated. We are also experiencing a very decided decreased maintenance cost in the rolling stock department, amounting to at least \$100 per car per year, due to the work of rehabilitation which we have carried out in the past three years on our track system, so that we are not only receiving a very substantial benefit in reduced maintenance cost of track, but we are also receiving a large benefit from reduced maintenance cost of equipment and other benefits due to increased comfort of car riders and people who live along the lines.

DISCUSSION.

DUGALD C. JACKSON.* The moving pictures we have just seen show something that ought to be interesting to us, and that is the traffic that goes on while the construction is proceeding. One of the cities that has recently had to repair a track in the city proper, put into effect a method of modern mechanical construction, and the citizens saw how the work went along and actually requested that in order to facilitate the work and get the interference with business out of the way, that each block as it was to be reconstructed, should be closed to traffic, except on the sidewalks, so that the whole thing could be done as rapidly as possible in that block, giving the street railway construction gang the whole width of the roadway to carry on its work. In that way they were actually able to clean up a block in about ten days, — to tear up the track and put down the new track and pave; and the merchants considered they had saved much in disturbance of their business by having vehicular traffic shut off and having the street open in a briefer time than would otherwise have been possible.

That is an aspect municipal engineers may well consider. Of course there is not so much difficulty with traffic in the country. The Elevated Railroad must have that worry very definitely.

MR. WALKER. The question is asked as to how the flangeway is kept in place with the common Tee rail? There

* Professor of Electrical Engineering, Mass. Inst. of Tech., Cambridge, Mass.

are two general methods employed. One method is to cut off the corners of the blocks for the flangeway and the other is to lay the stone block against the head of the rail, with an inch wooded strip between the rail and the block, which forms the flangeway. The base of the flangeway is filled with cement grout.

A good example of this is the State highway built for the Town of Andover from the Academy to Elm Square, a little less than a mile. A Tee rail was used, and stone paving on a concrete base. The flangeway was made by putting in a wooden strip.

In Fall River we have employed both methods, one to cut the corners of the blocks off and the other to put the blocks up against a wooden strip. With macadam it is rolled up at the head of the rail and cut off afterward.

With reference to the relative quietness of the Tee rail and the girder rail we find that the Tee rail is the more quiet. Where the rail is uniform section, it doesn't seem to set up the vibration that the eccentric section of the girder rail does. It does not corrugate so rapidly. I think I am safe in saying that this corrugation has something to do with electric traction. We do not get it on steam tracks. It may be due to unequal slippage of the wheels. Every engineer I ever met has difficulty in assigning a cause to it. We do get them, however, and the only way is to take out the rail or grind it down. The girder rail is very noisy.

Prof. Jackson suggests that corrugations do occur in steam railroad track, and that on the Pennsylvania Railroad track he has noticed them near the stations where the trains start. These looked very much like the electric railway corrugations.

The only corrugations I have ever seen in steam railroad track have usually been around the water station or coal station where there was actual slippage and burning of the rail, and that is entirely different from the corrugations in an electric rail.

You might see them on approaching sides of the station where they were operating under steam and put on the brakes. We get them on down-hill tracks and not on the opposite up-hill tracks. This may be due to the motors being under power

and the motorman having the brakes on and possibly the motors not working together and getting unequal slippage. We get them both on curves and on straight track. We sometimes get one rail corrugated on a straight track, and not the other. It is my belief that it is due primarily to unequal action of the motors on the car.

Questions are asked as to the cost of electric tamping machines and as to the relative cost of rehabilitation and new tracks. The cost of a four tamper machine is about \$1 600. In addition to the tampers a converter is required which is a large part of the cost. An air tamper would probably cost \$2 400 to \$2 500.

Very roughly the cost of a city track, exclusive of paving, is in the neighborhood of \$5.50 a foot. Rehabilitation of a paved track is not carried out in the same manner as the rehabilitation of a track in the country. About all you can do in the city is to put in a tie here and there, repair joints and weld them. It is costing our company nearly \$20 to repair a joint in a paved track, with concrete base and granite block pavement. That includes digging out the blocks, digging out the concrete, preparing the ties, welding the joint, surface welding it and grinding it. There are two joints in a rail length, which would make it \$40 a rail length. The rails are 60 ft. long, so that amounts to about 67 cents a foot of track, which is not large compared with new track. If the life of the track is increased one year we prefer this method to tearing it up. On a country line new track costs \$3.50 to \$4 a foot. Our rehabilitation work including welding, overhauling, ballasting, renewing a few of the ties, lining and surfacing, costs probably at least \$2 a foot of track. In a great many cases where the rails were supposed to be completely worn out we have been able by the development of the methods which you have seen to re-use the old rails to a very large extent, and you will find that old rails were used on 100 to 150 miles of the track which we have rehabilitated.

Sometimes we can reverse the rail but usually it is not worn enough on the gage side to swap it, except on curves. That practice is customary both on steam and electric lines and is one advantage the Tee rail has over the girder.

Prof. Jackson asks "if steel cost one-third less than it does would you do as much rehabilitating?"

We would do the work if the rails were not costing us anything, because it costs a lot of money to take out the old rails. I wouldn't want to be held to that absolutely, but the rails must be in very bad shape before they would be taken out.

When I was in Harrisburg I saw at the shops of one of the steel companies rails which the Pennsylvania Railroad had sent in to have 18 inches cut off the ends on account of battering, after which they will be used again. At the joints the rail takes a compound curve, a sharp dip at the end, which you cannot take out with rail benders. It also takes a long bend. This long bend we have taken out with our vertical benders. This occurs in the 9-inch rail and the light Tee rails. I am inclined to think if they cut off 12 or 18 in. of the rails at the end they should afterward use rail-benders to take out the long bend. So far as I know steam railroad engineers have not yet used these vertical rail benders.

A great many street railways are built with a concrete base. The Detroit Municipal Railway built about 80 miles of track using 70-lb. rail on light steel ties, set in concrete. Some engineers believe that is the solution. I am not prepared to say. I believe the Boston Elevated has used it. In Lowell there is a double track, one on steel ties, one on wooden ties. An examination of these tracks recently indicated the rails were working well on both. The rails wear out before the ties. Even on the Eastern Massachuettts we anticipate the rails will wear out first. Between Boston and Chelsea the life of the rails is only 8 or 9 years.

MEMOIR OF DECEASED MEMBER.

ANDREW M. LOVIS.*

ANDREW M. LOVIS, son of Ambrose Lovis and Harriet (Howes) Lovis, was born in Boston on December 2, 1855.

He was educated in the Boston public schools and the Boston English High School, graduating with the class of 1873.

After leaving school, he entered the office of Thomas Doane, C.E., of Charlestown, Mass., remaining there for three years as student in engineering; then one year, 1876, as special student at the Massachusetts Institute of Technology; from 1877 to the fall of 1882 was connected with the Union Pacific Railroad on surveys and location of new lines in the Northwest; was transitman until 1881, then promoted to engineer in charge of surveys and location on the Utah North Railroad and Oregon Short line. In the winter of 1882 and 1883 he left the employ of the railroad and went to Europe for about a year. On his return he was connected with the Boston & Lowell Railroad as Assistant Engineer and in private business doing local engineering work from 1883 until 1895. For four years he was engaged in mercantile business.

In 1895, Mr. Lovis was appointed as Assistant Engineer in the Massachusetts Highway Commission. In 1900 he was made First Assistant Engineer, retaining that position until 1921, when he was made Bridge and Designing Engineer until his death on April 25, 1922.

Mr. Lovis was a member of the Boston Society of Civil Engineers, the American Association of Engineers, and the American Concrete Institute.

He married, in 1886, Miss Margaret A. Banks of Annapolis Valley, Nova Scotia, who survives him, together with one daughter.

* Memoir prepared by A. W. Dean and John R. Rablin.

Mr. Lovis, in his twenty-seven years of public service, had done much toward the improvement and perfection of the method and results used and attained in the construction of highways and bridges throughout the Commonwealth of Massachusetts, and enjoyed the utmost respect of all those with whom he came in contact.



BOSTON SOCIETY OF CIVIL ENGINEERS
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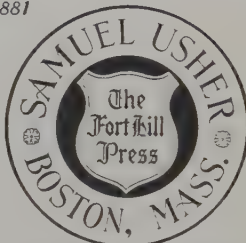
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